



JUNTOS

UNIT ONE

THE BORDER ENVIRONMENT: OUR SONORAN DESERT HOME

Lesson 1.

Welcome to "Juntos": What Do We Already Know About Our Desert Home?

Lesson 2.

Where in the World?: Natural and Cultural Geography of the Sonoran Desert

Lesson 3.

The Sonoran Desert Ecosystem: Sensing and Describing Biotic and Abiotic Factors

Lesson 4.

Abiotic Factors in a Desert Environment: Temperature and Evaporation of Water

Lesson 5.

Biotic Factors of the Sonoran Desert: Common Plants and Animals Sharing Our Desert Home

Student Evaluation



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WELCOME TO "JUNTOS" WHAT DO WE ALREADY KNOW ABOUT OUR DESERT HOME?

LESSON OVERVIEW

This is the introductory activity for the Juntos program. Following a general introduction to Juntos and its unique features, students will complete an environmental knowledge survey to reveal what they already know about their home environment. Students will interview each other using a survey form (provided), then review their responses as a class. Upon completing this activity, you and your students will have a better understanding of your own environmental knowledge. The purpose of this activity is to generate interest in the Juntos program and to give students an idea of what constitutes environmental information --knowledge that is vital to our lives in this desert region. This activity may also be used as a pre-assessment to evaluate knowledge gained through the Juntos program.

TEACHER PREPARATION

- ✓ Be sure each student has a copy of the Student Activity: *Student Environmental Knowledge Survey Form: What Do We Already Know About Our Desert Home?*

TEACHING STRATEGY

1. **Introduce Juntos.** Whether you are conducting these activities to augment your text book or as a self-contained unit of study, it is worth noting to students that these activities are being conducted in high school classrooms throughout the border region in Sonora and Arizona including the Tohono O'odham Nation. Students, like themselves, are studying and learning about their environment and engaging in various environmental science projects. Before beginning the lessons, we suggest presenting an introduction to the program's regional focus and tailored development process (involving teachers such as yourself). Specifics of the development process are presented in the introduction to this teacher's guide.
2. **Introduce survey activity.** Group students in pairs of their or your choosing. Explain that they will take turns interviewing each other. Clarify that since this is a survey about pre-existing knowledge, you will be providing them with minimal assistance with unfamiliar words or concepts. It will be up to the pairs to interpret the questions and up to the individuals being surveyed to respond to the best of their knowledge.
3. **Review surveys as a class.** Have students refer to their survey forms and give students time to preview them and ask any general questions about them. Answer questions according to your judgment.
4. **Conduct interviews.** Give students adequate time to conduct the interviews. One student should complete their entire interview before the pair switches roles.
5. **Review completed surveys.** As a class, review each question and allow students to share their responses. Because some questions may have numerous correct responses, there is no real key provided for this exercise. However, be sure to explain that the answers will be investigated throughout the Juntos program.
6. **Conduct a discussion of responses.** Ask students which of these questions they think are most important. Which seem to have little or no importance? Lead a discussion as to

LEARNING OBJECTIVES

Upon completion of this lesson, students will be able to:

- list and describe at least two reasons why they are studying the environment of their own region.
- list at least two specific facts about their regional environment that they already knew and three things about their environment that they would like to learn.

TIME NEEDED

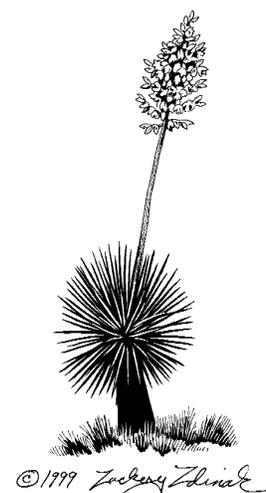
This activity can be completed in one class period.

MATERIALS NEEDED

- Student Activity: *Student Environmental Knowledge Survey Form: What Do We Already Know About Our Desert Home?*

CURRICULUM TIES

Arizona: 3SC-P4
O'odham: A.2.8; A.4.3



why these questions might be considered important environmental information. After the discussion, have students either save or turn in their surveys to use for future comparison to a follow-up survey.

EXTENSIONS

Consider conducting a class tally of responses. Have students create a "class tally form" which may be used to record a tally of their responses. Complete the "class tally form" together, with students reading the questions aloud, tallying the responses, and recording the results. Some questions will be easily tallied (e.g., how many students knew five birds, four birds, etc.) while other questions will need responses written out such as, "How many wrote that they get their water from underground?" "How many wrote that they get their water from the tap?."

9. Name three mammals native to your area.
10. Name 5 different kinds of native birds that occur in your area.
11. What is the source of your community's water supply?
12. Where does your garbage go? Describe as well as you can where it goes after it leaves your home.
13. Is there a recycling program in your community, if so, list the types of items that you can recycle.
14. What threatened or endangered species -- plants or animals -- live in your area?
15. What is the average rainfall in your area? What is the annual evaporation rate in your area?
16. Does your region have rainy seasons? If so, when are they?
17. Name three ways people rely on the land in your area (growing things, building things, etc. be specific).
18. List and describe two important environmental issues in your area.

WHERE IN THE WORLD? NATURAL AND CULTURAL GEOGRAPHY OF THE SONORAN DESERT

LESSON OVERVIEW

This activity gives students the opportunity to gain information about significant geographical features of the Sonoran Desert border region. Using clues from a crossword puzzle (which includes reference indices to aid in map locations), students locate and identify significant natural, cultural, and political features on a provided map of the Sonoran Desert region. Students also complete additional map exercises further demonstrating the kinds of information maps may provide.

TEACHER PREPARATION

- ✓ Be sure each student has a copy of the following: Student Activity - Map: *The Sonoran Desert Borderlands*, and the Student Activity - Study Guide: *Names and Places in the Sonoran Desert* (Puzzle and Clues).
- ✓ Review the Background Information Fact Sheet: *Where in the World is the Sonoran Desert?* and assign this as background reading for your students.
- ✓ Have ready the overhead transparency map: *The Sonoran Desert Borderlands*

TEACHING STRATEGY

1. **Introduce** *The Sonoran Desert Borderland* map using the overhead transparency as a guide. Refer students to their maps: *The Sonoran Desert Borderlands* and point out the various features of the map. Key features of the map include political boundaries, relevant locations (such as your community), and protected natural areas. The communities involved in the Juntos program should also be pointed out and your students reminded that students from other high schools in those communities are doing these same activities (Nogales, Sells, San Simon, Ajo, and Yuma, Arizona and Nogales, Sonoyta, and San Luis Rio Colorado, Sonora).
2. **Background review.** Review the background information with students using their maps as a reference and guide for specific information. The amount of background information detail you share with the students is up to you. It is important that they understand basic map reading skills and realize that maps can give us a variety of information, beyond just locations. You might also discuss geographic, cultural, or ecological information specific to the Sonoran Desert Borderlands.
3. **Student activity.** Have students refer to their crossword puzzle and clues as you explain the activity. You may need to do a sample exercise to demonstrate how the answers on the crossword puzzle may be found on the map using the reference coordinates. Students may work in pairs to complete their crossword puzzles and map exercises.
4. **Review.** Go over the completed maps and puzzles as a class, calling on students to share their answers.
5. **Class discussion.** Wrap up the activity with a discussion about the kinds of information

LEARNING OBJECTIVES

Upon completion of this lesson, students will be able to:

- locate and describe the significance of at least 5 different places in the Sonoran Desert Region.
- list at least 3 types of information that may be learned from maps.
- locate on a map the political boundaries of Sonora, the Tohono O'odham Nation, the Cocopah Nation, and Arizona.
- locate and describe the significance of at least 2 established protected areas in the region.

TIME NEEDED

This activity can be completed in one class period.

MATERIALS NEEDED

- Background Information Fact Sheet: *Where in the World is the Sonoran Desert?*
- Overhead transparency map: *The Sonoran Desert Borderlands*
- Student Activity - Map and Map Exercises: *The Sonoran Desert Borderlands*
- Student Activity - Study Guide and Crossword Puzzle: *Names and Places in the Sonoran Desert*

CURRICULUM TIES

Arizona: 1SC-P2
O'odham: A.5.3; A.7.3



we can obtain from maps. Did students gain any new environmental knowledge that they might have used to answer some of the questions on the previous activity's survey?

EXTENSIONS

The significance of our regional parks and protected areas. Have students conduct research to find additional information on the parks, monuments, and biosphere and wildlife reserves on the map. Students may refer to the Student Guide to Environmental Resources and opportunities for further information and contacts.

Map your own community. Have students create maps of their own neighborhoods or communities and include areas of special significance to them. Have them locate areas where there tends to be more vegetation or wildlife. Are these designated parks or vacant lots?

WHERE IN THE WORLD IS THE SONORAN DESERT?

Deserts

Deserts occur throughout the world. In fact, it is estimated that at least one fifth of the world's land surface is desert. Although there are numerous areas worldwide classified as deserts, each is distinctly different from the others. What deserts have in common are the characteristics that define them as deserts: limited rainfall (typically less than ten inches per year), a high rate of evaporation, wide-ranging temperatures, and frequently, strong winds. While some deserts have rainfall of more than ten inches per year, their evaporation rate greatly exceeds the amount of rainfall they receive. Therefore deserts are also defined as areas in which the evaporation rate exceeds rainfall.

Another commonality of deserts is their geographic location. Deserts typically occur at or near 30 degrees latitude, both north and south of the equator. High atmospheric pressure zones prevail in these areas resulting in a belt of warm, dry air descending around the world at these latitudes.

Another geographic factor contributing to the occurrence of deserts is called the rain shadow effect. A rain shadow occurs when coastal air, laden with moisture, rises and cools as it meets inland mountains. As the air rises and cools, it loses most of its moisture through precipitation. The air descending down the other side of the mountain range is thus warm and dry, contributing to the desert conditions.

Sonoran Desert

The Sonoran Desert is here because of both high atmospheric pressure and the rain shadow effect. The Sonoran Desert is located roughly between latitudes of 23 and 35 degrees north. Warm, dry air predominates in this region. As well, contributing to the dry conditions in the northern Sonoran Desert, are the southern Sierra Nevada, Sierra de Juarez, and the Sierra San Pedro Martir which receive much of the moisture from the air moving east from the Pacific Ocean.

Our home, the Sonoran Desert, is uniquely situated on the North American continent. It covers approximately 120,000 square miles and spans over two countries and several Native American Nations. The northern Sonoran Desert is located in the U.S. states of California and Arizona. Within the Sonoran Desert in Arizona are the Tohono O'odham Nation and the Cocopah Nation. The southern part of the Sonoran Desert is located in the Mexican states of Sonora, Baja California Norte and Baja California Sur (including islands of the Sea of Cortez). The Seri and the Yaqui are native to the Sonoran Desert in Sonora while in Baja California, live the Pai Pai, Kumiai, and Kiliwa.

Besides being home to a diversity of human cultures, the Sonoran Desert is also home to one of the most diverse assemblages of plants and animals of any desert on Earth. The diversity of life in this desert is related to the amount of rainfall received as well as to the diversity of the desert landscape itself. Our desert receives more annual rain than most deserts (ranging from 14 or more inches in the higher, more eastern areas to less than 2 inches in the lower Colorado River valley area). The surface features of the landscape include rocky outcrops, gently sloping bajadas, high, rocky mountains, deep canyons, wide, flat plains, rolling hills, sand dunes, volcanic peaks, lava flows, winding sandy arroyos, and just about every other kind of landscape feature one can think of. This variety of landscape, creates a variety of habitats which contributes to the area's biological diversity. Fortunately, we humans recognize the uniqueness and beauty of our desert home. Within the Sonoran Desert are numerous places set aside as protected areas because of their unique geological or biological features. Such area include Biosphere Reserves, National Monuments, Wildlife Refuges, and State Parks. Protected areas are established to protect and manage the land (or body of water) and the plants and animals that occur there. Protected areas are often home to plant or animal species which may be threatened or endangered and therefore need special attention. For example, Organ Pipe Cactus National Monument in Arizona has the largest population of organ pipe cactus in the United States, they occur almost nowhere else in the U.S. The vaquita and totoaba are both endangered

marine species which only occur in the protected northern Sea of Cortez in Mexico. The bobwhite quail and Sonoran pronghorn antelope have both been reintroduced to the Buenos Aires National Wildlife Refuge in Arizona. The Sonoran pronghorn antelope is also a species of special interest in the Pinacate Biosphere Reserve and Cabeza Prieta National Wildlife Refuge.

The Sonoran Desert is home to a diversity of plant, animals, and people. It is located in an area rich in culture and nature. We are fortunate that here in our special little corner of the planet, we are becoming more aware of our plant, animal, and human neighbors. Our awareness is also growing regarding the need to conserve and protect this area's unique cultural, geological, and biological features. The more aware we are, the better stewards we can be of our desert home.

Mapping the Sonoran Desert

When looking at a map of the Sonoran Desert (or any ecosystem), one may wonder how the boundaries are decided. Where does the desert end and another ecosystem start? In fact, scientists agree that there is not one exact place where the desert stops or starts. The primary factor scientists use to demarcate the Sonoran Desert (and other ecosystems) is the vegetation. Every ecosystem has distinctive plants which are associated with that ecosystem, either by themselves or in association with other plants. Our Sonoran Desert has several distinctive species (such as columnar cactus, other succulent species, and leguminous trees such as mesquite and paloverde) which help scientists determine its approximate boundaries. Based on those criteria, the Nogales area is usually considered to be the eastern boundary of the Sonoran Desert. Nogales is situated near the convergence of the Sonoran and Chihuahuan Deserts, is located at a higher, cooler elevation, and receives more rainfall than the rest of the Sonoran Desert.

Give the approximate distance and direction of each of the following locations from your community.

1. Baboquivari Mountains: Distance _____ Direction _____

2. Pinacate Biosphere Reserve: Distance _____ Direction _____

3. Cibola National Wildlife Refuge: Distance _____ Direction _____

List two places on your map which you would like to visit and explain why you would like to go there.

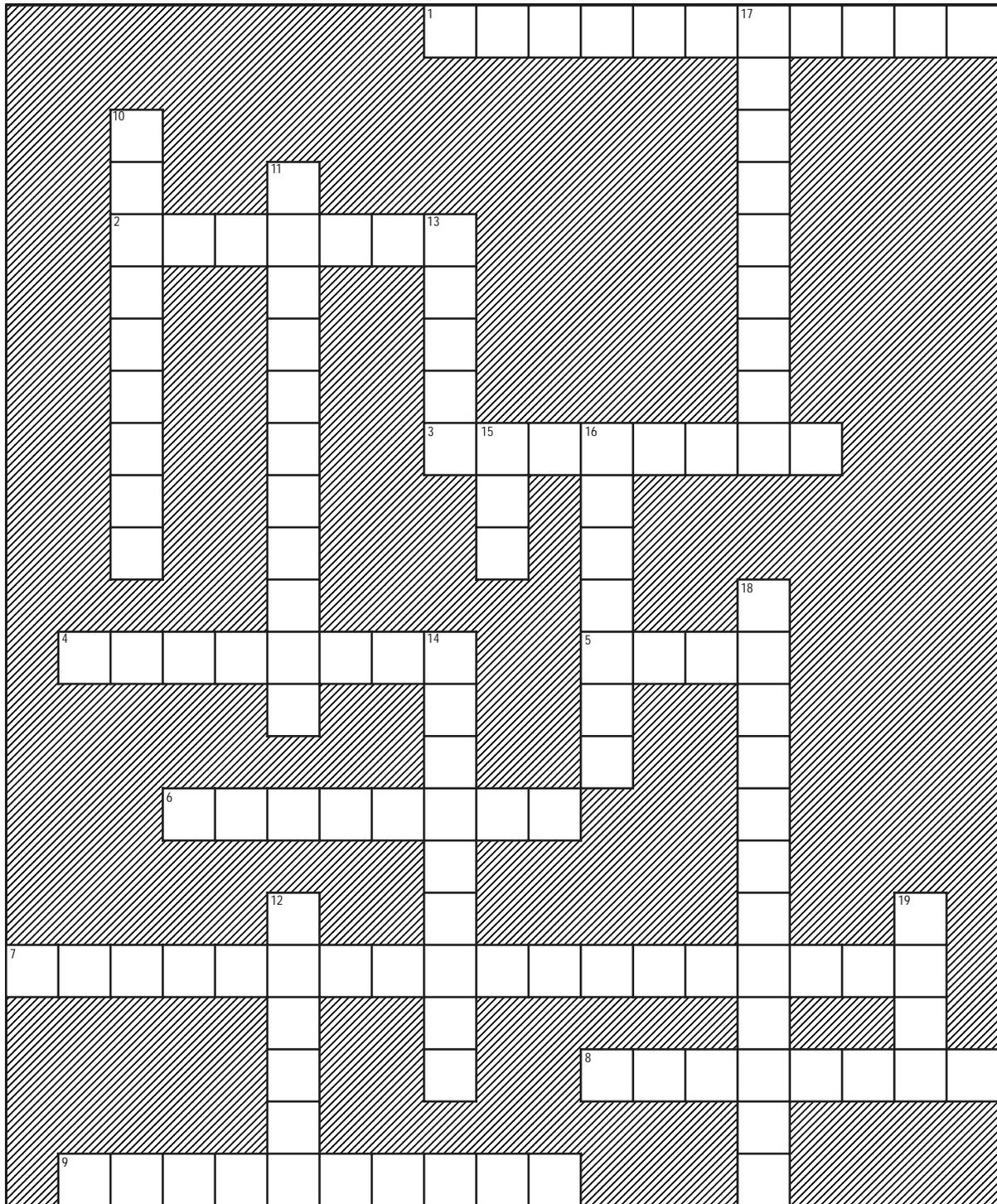
4. Name of place _____ Why you want to go there

5. Name of place _____, Why you want to go there

6. Color the different features of your map. Use the key for consistency in the colors you use for wildlife refuges, biosphere reserves, national monuments, and mountain ranges. Be careful not to color over the name of the features or locations. You may wish to highlight the names of some of the locations on the map.

NAMES AND PLACES IN THE SONORAN DESERT

Directions: Use the clues on the next page to complete the crossword puzzle below. Use the reference indices (in parentheses beside each clue) to find and label the correct location on your map.



ACROSS

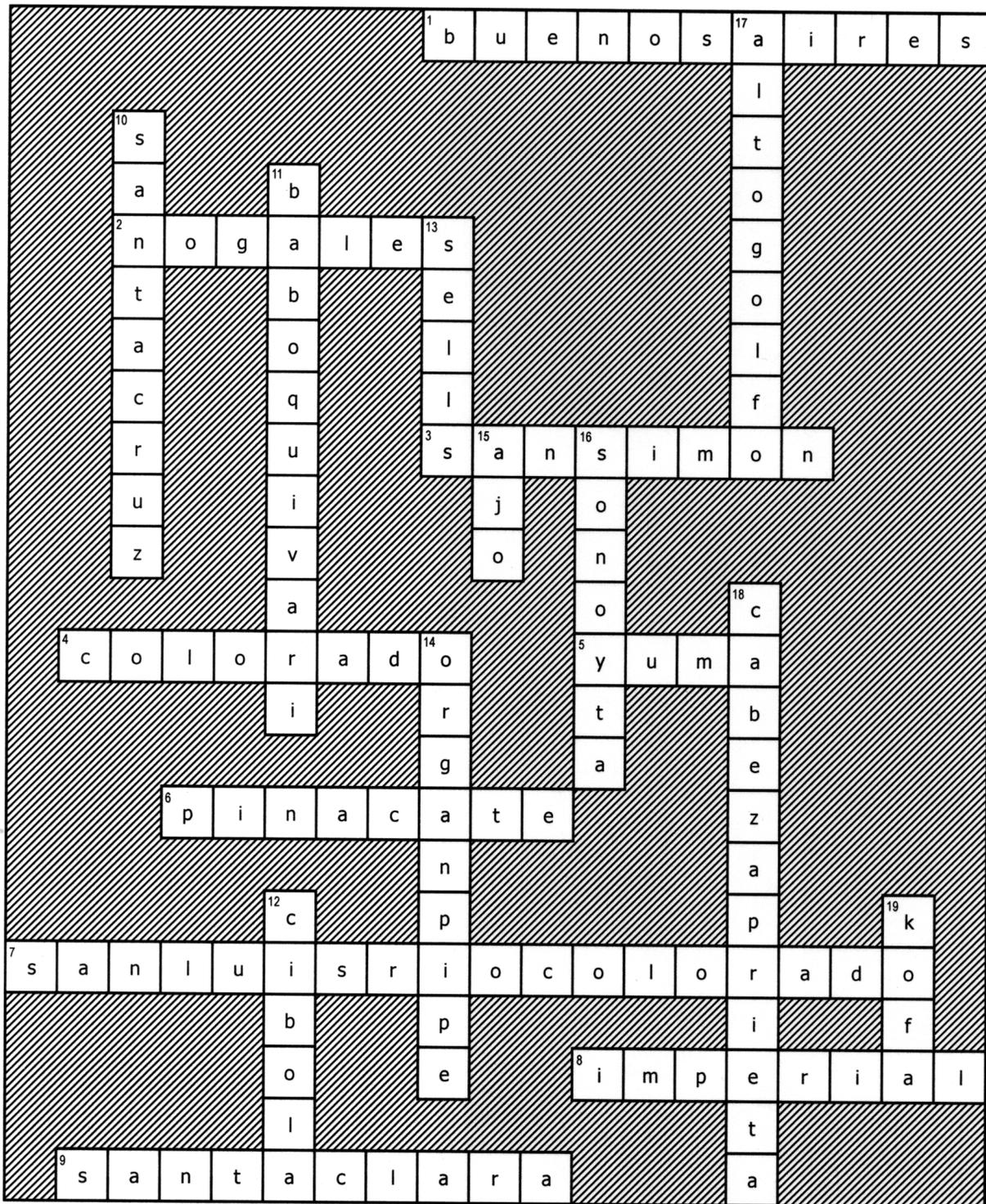
1. This wildlife refuge protects the largest tract of ungrazed grasslands in Arizona. Both the masked bobwhite quail and pronghorn antelope have been reintroduced on this refuge. (O,8)
2. These "twin" towns are located in what might be considered the eastern fringe of the Sonoran Desert. The area is higher in elevation than most of the desert and as a result, there are more oak, juniper, and other trees such as black walnut, for which the towns were named. (Q,10)
3. This community is located in the Pisinmo District of the Tohono O'odham Nation. Tohono O'odham High School is located here. There is a wash in the area of the same name. (K,6)
4. This river has its headwaters in Wyoming and drains portions of seven states in the U.S. and two states in Mexico. It flows 1,400 miles from elevations above 14,000 feet to sea level at the Gulf of California. (B-D,1-7)
5. This town is named for the collective group of Native Americans (including Cocopah, Mojave, and Quechan) who were the original inhabitants of the lower Colorado region. This was the location of a major, historical Colorado River crossing and "gateway to California." This is a very arid town with an average annual rainfall of only 3.17 inches. (D,4)
6. This area is known for its stark desert beauty in a landscape of rugged lava flows, craters, and volcanoes. It was named for the black beetle that stands on its head when alarmed. Sonoran pronghorn antelope occur here. This is a sacred area to the Tohono O'odham. It is also classified as a Biosphere Reserve. (D-J,5-9)
7. This Mexican border town is located in a prime agricultural area. Crops there are watered by canals of the Colorado River. It is a very arid community with a yearly rainfall of only 2.77 inches. It is near the ocean, located 137 feet above sea level. (C,5)
8. This national wildlife preserve protects over 25 thousand acres of desert uplands and riparian habitat along the lower Colorado River. Waterfowl and desert bighorn sheep are among the wildlife that occurs here. (D,2-3)
9. A cienega is a marsh or swamp-a lowland filled with water most of the time. There are but a few natural cienegas remaining in our desert region. This one is located in the Upper Gulf Biosphere Reserve along the southern Colorado River near the mouth of the Sea of Cortez. It is home to numerous birds including the endangered Yuma clapper rail and is a nursery area for many species of fish. (C,7)

DOWN

10. This river has its headwaters in Arizona and first flows south into Sonora. It turns north and re-enters Arizona at Nogales. The river is rich with historical significance including several missions established on its banks by Father Kino. (L-R,1-10)
11. This mountain range and sacred peak is the home of I'itoi, creator and Elder Brother of the Tohono O'odham. This peak is 7,730 feet in elevation. (N,7)
12. Geese, sandhill cranes, and other wintering waterfowl are protected at this wildlife refuge. The endangered Yuma clapper rail nests here in this mostly riparian habitat. (C,1)
13. This town is the center of governmental activity on the Tohono O'odham Nation. Once called Indian Oasis, it was renamed after the commissioner of Indian Affairs at the time the reservation was established. (M,7)
14. This national monument protects 330,688 acres of the Sonoran Desert, most of which is classified as wilderness. It is also classified as a Biosphere Reserve. This area is bordered on the east by the Ajo Mountains, and on the south by the U.S. - Mexico border. A small spring, called Quitobaquito, is located within the Monument's boundaries. It is named for a certain plant that occurs there. (I-K,6-7)
15. This town is considered to be the birthplace of copper mining in Arizona. Although the name means "garlic" the town is actually named from a Tohono O'odham word for a special paint which was derived from minerals in the area. (J,5)
16. This town was originally settled by the O'odham as a seasonal camp and was called Sonoidag. A river by the same name runs through this town. This is the location of one of the few border crossings between Mexico and the United States in the western Sonoran Desert. (J,7)
17. This biosphere reserve was established to protect the unique delta region of the Sea of Cortez. The endangered vaquita and totoaba are two of the protected species which occur in this area. (B-G, 6-11)
18. Of the 860,000 acres on this refuge, 803,000 are classified as wilderness. The "Devils Highway" crosses through this National Wildlife Refuge. Sonoran pronghorn antelope, desert bighorn sheep, and the lesser long-nosed bat occur here.(F-J,4-6)
19. This refuge is home to the largest population of desert bighorn sheep in the United States. It is also one of the few places in Arizona where native fan palms grow. Its name is extracted from "King of Arizona." (D,1)

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THE SONORAN DESERT ECOSYSTEM

SENSING AND DESCRIBING BIOTIC AND ABIOTIC FACTORS

LESSON OVERVIEW

This lesson provides a review of basic ecological terms and focuses on the primary components of ecosystems: biotic and abiotic factors. The lesson includes an outdoor component which serves to get the class out into the environment in a focused and orderly manner and to encourage and hone observation skills of the students. The lesson begins with a review of ecology terms, after which the class ventures outside to make quiet observations of abiotic and biotic factors in their immediate environment. Observations are recorded on a provided data sheet. Students will also describe how the observed abiotic factors affect the biotic factors.

PREREQUISITE KNOWLEDGE

Although not required, students should be familiar with some basic ecological terms. While offering a definition of "ecosystems," this activity focuses on the abiotic and biotic factors of ecosystems and specifically the abiotic and biotic characteristics of our Sonoran Desert ecosystem. Students should be aware that there are other types of ecosystems in the world and that each ecosystem has its own unique abiotic and biotic factors.

TEACHER PREPARATION

- ✓ Be sure each student has a copy of the following: Student Activity - Data Sheet: *Abiotic and Biotic Factors - Outside Observations*, Student Activity - Study Guide: *Review of Ecology Terms*, and Background Information Fact Sheet: *A Review of Ecology and the Sonoran Desert Ecosystem*
- ✓ Review the Background Information Fact Sheet: *A Review of Ecology and the Sonoran Desert Ecosystem*
- ✓ Have ready, an overhead projector
- ✓ Have ready the overhead transparency master: *Review of Ecology Terms*
- ✓ Locate an outdoor setting where you can take students to sit quietly and observe the environment. The location should have a relatively good diversity of plants and animals (even urban species such as eucalyptus, pigeons, and sparrows are fine for this activity).

TEACHING STRATEGY

1. **Prepare students.** Prepare students for this lesson by explaining that you will be doing a review of very important ecological vocabulary words. Point out the overhead transparency (or chalkboard) and explain that as you define and discuss the terms, they should fill in the blanks (write the ecological terms) on their own copies of *Review of Ecology Terms*.
2. **Review terms.** Using the transparency master as a guide, review the ecological terms and definitions, writing in the correct vocabulary word as you go. Involve students in this review either by having them read the definitions, verbally filling in the blanks with the appropriate terms, or writing the terms on the master for the rest of the class.

LEARNING OBJECTIVES

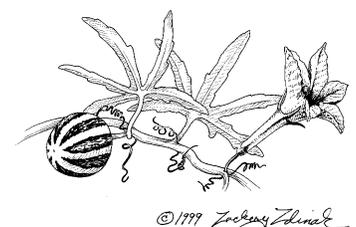
- Upon completion of this lesson, students will be able to:
- define the terms ecology, ecosystem, abiotic, biotic, species, population, and biological diversity.
 - list and describe at least 3 abiotic factors of an ecosystem.
 - identify at least 3 biotic factors of an ecosystem.
 - describe at least 2 ways in which a given abiotic factor affects living components of an ecosystem.
 - use observation skills (seeing, hearing, feeling) to identify biotic and abiotic factors of a given ecosystem.

TIME NEEDED

This activity can be completed in one class period.

MATERIALS NEEDED

- Overhead projector (see "Logistics - Notes to the Teacher" if no overhead projector is available)
- Background Information Fact Sheet: *A Review of Ecology and the Sonoran Desert Ecosystem*
- Overhead transparency master: *Review of Ecology Terms*
- Student Activity - Study Guide: *Review of Ecology Terms*
- Student Activity - Data Sheet: *Abiotic and Biotic Factors -- Outside Observations (on back of Study Guide)*



3. **Discuss abiotic and biotic factors.** Following completion of the review of ecological terms, explain that the rest of this lesson will focus specifically on the abiotic and biotic factors of ecosystems, especially our own Sonoran Desert ecosystem. You may want to review additional information about the Sonoran Desert ecosystem as presented in the background information fact sheet: *A Review of Ecology and the Sonoran Desert Ecosystem*.
4. **Review student data sheets.** Have students refer to their copies of the Student Activity - Data Sheet: *Abiotic and Biotic Factors--Outside Observations*. Review the data sheet, answering any questions about the activity.
5. **Prepare students for going outside.** Explain that the class will next be going outdoors to observe abiotic and biotic factors first-hand! Point out that as they go outside and observe their environment, they will likely notice a variety of obvious living things such as insects, birds, and plants. However, each of those organisms is acutely aware of and influenced by the ambient abiotic factors-they should try to be also. Remind them to consider things such as temperature, shade, moisture in the air, where buildings are located (therefore creating shade or "substrate"), etc. Encourage students to use more than their sense of sight to make observations. (Do they feel hot? Can they feel the wind? What can they detect using their sense of smell? etc.) Explain that this is not a team or paired activity, but a solitary one in which they conduct observations quietly and individually using their own powers of observation. Review any classroom management rules you have regarding outside behavior. It may be good to explain the physical boundaries where the activity will take place in advance of going out.
6. **Go outside and complete data sheets.** Have students find a comfortable location for conducting their observations. Allow students 15 minutes to write down as many biotic and abiotic factors as they can observe (or sense). If they have time, they may begin to answer some of the discussions questions, otherwise give them time to complete the questions upon returning to the classroom.
7. **Return to the classroom.** Once back in the classroom, give students time to complete the study questions then review the data sheets as a class. On the board, list all of the biotic and abiotic factors observed by the students. Conduct a discussion using the questions from their data sheets as a guide.

A REVIEW OF ECOLOGY AND THE SONORAN DESERT ECOSYSTEM

Ecosystems

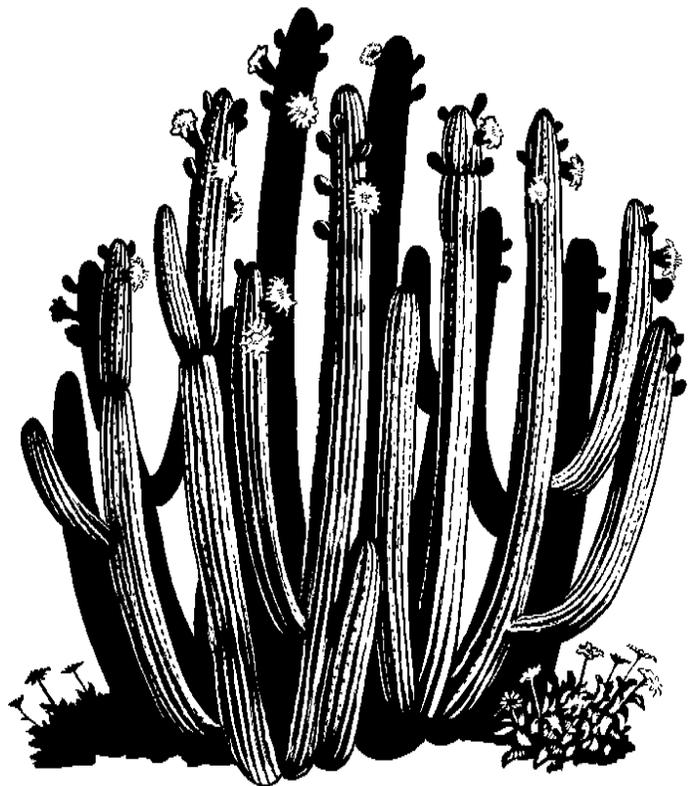
Ecology is a field of study that looks at the interrelationships between living things and their environment. All of the living and non-living things in a given area, and their interactions, make up an ecosystem. Thus, ecology can also be defined as the study of ecosystems.

Ecosystems can be as large as the entire planet (or larger perhaps) or as small as a drop of pond water. Size is unimportant, the definition is based on the existence of both living and non-living factors interacting in a given space. The interactions of living things with non-living things in an ecosystem include such activities as breathing, holding on (as roots in soil or lichen on rocks), keeping cool, keeping warm, drinking, obtaining nutrients, bathing, finding shelter, etc. In other words, living things rely upon and are influenced by the non-living things in their ecosystem. The environment is the medium (or living conditions) created by the combination of the non-living factors of the ecosystem.

Somewhat different from an ecosystem is an **ecoregion**. An ecoregion is a large expanse of land and/or water delineated by similar climate, topography, and biological communities. The difference between an ecoregion and an ecosystem is that an ecoregion is more location-defined. The term Sonoran Desert Ecoregion more closely describes the physical place whereas the Sonoran Desert Ecosystem refers to the interactions of the abiotic and biotic factors. For example, it is more appropriate to say, "We live in the Sonoran Desert Ecoregion" as opposed to, "We live in the Sonoran Desert Ecosystem."

Biotic Factors

The living things in an ecosystem are called the **biotic factors**. Living things are relatively easy to identify: birds, plants, mammals, insects, reptiles, fish, etc. Living things are classified by a very organized system that takes into account the evolutionary relationship between the organisms. A group of closely related organisms which can breed to produce similar offspring is called a **species**. A species is the smallest level of classification in which animals or plants are grouped (although sub-species do exist). A group of organisms of the same species living in a specific area is called a **population**. In a given ecosystem there may be a large variety of different kinds of plants and animals or there may only be a few. The measure of the number of different kinds of plants and animals is called **biological diversity**. Biological diversity not only refers to the number of different kinds of species (which is more accurately termed species diversity), it may also refer to ecosystem diversity (a measure of the variety of ecosystems in a given area) or to genetic diversity (a measure of the variety of genetic material within a species). All biotic factors rely on an appropriate habitat for their survival. A **habitat** is the place or type of place where an organism lives. It includes all of the necessary abiotic and biotic factors (food, water, shelter, etc.) for an organism to survive.



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Abiotic Factors

The non-living things in an ecosystem are called **abiotic factors**. Abiotic factors are things such as sunlight, temperature, parent rock (the non-living part of the soil), and moisture. Abiotic factors provide the conditions for life but also set the limits for living things in the environment. For example too much heat and not enough moisture can cause some plants to wither and die. Freezing temperatures may encourage some animals to migrate. The primary abiotic factors that influence life and dictate living conditions can be grouped and summarized as follows:

Climate (including temperature, sunlight, moisture, seasonal changes, photoperiod (duration of daylight), and wind)

Substrate (including parent rock and soil characteristics such as particle size, texture, pH, and chemical composition)

Geography (including latitude, longitude, and altitude--all of which influence climate)

Topography (including north - south exposure, steepness of slope, and general terrain)

Nutrient Cycles (including carbon, oxygen, nitrogen, sulfur, and phosphorous as atmospheric gases and soil minerals)

The Sonoran Desert Ecosystem

The Sonoran Desert ecosystem is a unique combination of abiotic factors forming an environment in which live a diverse assemblage of plants and animals. The geographic location of the Sonoran Desert is a primary contributing factor influencing the climatic conditions of the desert. With a mean latitude of 31.5 degrees north, the Sonoran Desert is subject to warm, high pressure atmospheric conditions which cause high temperatures, low precipitation, and high evaporation. The Sonoran Desert is considered a warm desert and often experiences temperatures of well over one hundred degrees on summer days. During the winter, temperatures can range from days in the seventies to nights below freezing. These climatic conditions, together with the geologic diversity of the landscape, create the living conditions to which a great diversity of flora and fauna have successfully adapted.

As with any ecosystem, it is not just the biotic and abiotic factors alone that define it, it is the interactions of those factors that make the ecosystem what it is. In the Sonoran Desert, the plants and animals have adapted to life in a hot, dry environment. They have learned to cope with extremes of temperature, lack of water, intense solar radiation, and poor soil conditions. They have developed survival strategies such as being active at night, dropping their leaves during times of drought, living underground, and conserving water in a variety of ways. The plants and animals of this ecosystem have also developed complex interactions and dependencies on each other to help them survive. Many animals seek shelter from the heat and sun in the shade of plants or even by excavating cavities into the plant's flesh. Animals have also structured their eating habits to the blooming of flowers and ripening of desert fruits. Many animals share underground burrows. The interactions are numerous, incredible, and sometimes bizarre. The Sonoran Desert is a dynamic system of these interactions. It is a place of extreme conditions and unique life forms which have adapted to those conditions. It is a place we are fortunate to call home.

REVIEW OF ECOLOGY TERMS

1. The study of the interrelationships between living things and their environment is called _____.
2. All the living and non-living things in a given area, and their interactions, make up an _____.
3. All the living things in an ecosystem are called the _____ factors.
4. All the living things in an ecosystem are affected by the non-living parts of the ecosystem, which are called the _____ factors, and include such things as _____.
5. A _____ is the place or type of place where an organism lives. It includes all of the necessary abiotic and biotic factors (food, water, shelter, etc.) for an organism to survive.
6. A group of closely related organisms which can breed to produce offspring is called a _____.
7. A group of organisms of the same species living in a specific area is called a _____.
8. A measure of the variety of different living things on Earth is called _____.
9. A large expanse of land and/or water delineated by similar climate, topography, and biological communities is known as an _____.
10. The area in which we ourselves live, taking into consideration all the abiotic and biotic factors is called the _____.

REVIEW OF ECOLOGY TERMS

Directions: Fill in the blanks as the definitions are reviewed by your teacher.

1. The study of the interrelationships between living things and their environment is called _____.
2. All the living and non-living things in a given area, and their interactions, make up an _____.
3. All the living things in an ecosystem are called the _____ factors.
4. All the living things in an ecosystem are affected by the non-living parts of the ecosystem, called _____ factors, and include such things as _____.
5. A _____ is the place or type of place where an organism lives. It includes all of the necessary abiotic and biotic factors (food, water, shelter, etc.) for an organism to survive.
6. A group of closely related organisms which can breed to produce offspring is called a _____.
7. A group of organisms of the same species living in a specific area is called a _____.
8. A measure of the variety of different living things on Earth is called _____.
9. A large expanse of land and/or water delineated by similar climate, topography, and biological communities is known as an _____.
10. The area in which we ourselves live, taking into consideration all the abiotic and biotic factors is called the _____.

ABIOTIC AND BIOTIC FACTORS
OUTSIDE OBSERVATIONS

Directions: Find a quiet place to sit and conduct your observations. In the table below, list as many abiotic and biotic factors as you can detect. Complete the discussion questions.

Abiotic Factors	Biotic Factors

Discussion Questions:

- 1. For each abiotic factor listed, describe how it might affect one of the biotic factors listed.*

- 2. Select one organism from the biotic factor list and suggest one or more ways it might affect (or interact with) another organism on your list.*

- 3. List several way you are personally affected by the abiotic factors in your environment.*

REVIEW OF ECOLOGY TERMS

Directions: Fill in the blanks as the definitions are reviewed by your teacher.

1. The study of the interrelationships between living things and their environment is called ECOLOGY.
2. All the living and non-living things in a given area, and their interactions, make up an ECOSYSTEM.
3. All the living things in an ecosystem are called the BIOTIC factors.
4. All the living things in an ecosystem are affected by the non-living parts of the ecosystem, called ABIOTIC factors, and include such things as AIR, SUNLIGHT, TEMPERATURE, ETC.
5. A HABITAT is the place or type of place where an organism lives. It includes all of the necessary abiotic and biotic factors (food, water, shelter, etc.) for an organism to survive.
6. A group of closely related organisms which can breed to produce offspring is called a SPECIES.
7. A group of organisms of the same species living in a specific area is called a POPULATION.
8. A measure of the variety of different living things on Earth is called BIOLOGICAL DIVERSITY.
9. A large expanse of land and/or water delineated by similar climate, topography, and biological communities is known as an ECOREGION.
10. The area in which we ourselves live, taking into consideration all the abiotic and biotic factors is called the SONORAN DESERT ECOREGION.

ABIOTIC FACTORS IN A DESERT ENVIRONMENT

TEMPERATURE AND EVAPORATION OF WATER

LESSON OVERVIEW

In this activity, you and your students will investigate aspects of sunlight, an abiotic factor which has great influence on our desert environment. Using the scientific method, students will conduct an experiment to determine the effect of sun and shade on the temperature and volume of water in a container. Two study sites will be set up, one in the direct sun and one in a shaded area. Graduated containers of water will be placed at both stations. A thermometer will be placed in each container. The temperature and volume of the water in the containers will be measured and recorded at intervals throughout the day. Students will make predictions, gather, graph, and analyze data, and articulate results. The purpose of the experiment is to demonstrate the dynamics of an abiotic factor that has great significance in our desert region. Extensions include calculations of evaporation in local waterways and a discussion of water transportation and storage in the desert.

PREREQUISITE KNOWLEDGE

For this exercise, students should be able to accurately read a thermometer as well as determine the volume of liquid in a graduated container (preferably with an understanding of reading at the bottom of the meniscus). Students should also be able to draw a line graph using an appropriate scale and plot data points on a graph. This is an ideal way to demonstrate practical use of a line graph with actual data that the students themselves collect.

TEACHER PREPARATION

- ✓ Be sure each student has a copy of the following: Student Activity - Data Sheet: *Abiotic Factors in a Desert*, Student Activity - Lab Report, and Background Information Fact Sheet: *A Review of Ecology and the Sonoran Desert Ecosystem*
- ✓ Review the Background Information Fact Sheet: *A Review of Ecology and the Sonoran Desert Ecosystem* (although you may have already read the fact sheet for the previous activity, it may be good to review the information in the "Abiotic Factors" section of that fact sheet)
- ✓ Prepare the four containers for this experiment. The two identical containers will be used to for temperature data and the two graduated containers will be used to for volume data. The graduated containers should be able to hold 250 ml of water and be clearly marked at every 5 ml interval if possible.
- ✓ Set up outdoor lab stations as follows:
 - Locate two lab station sites outdoors, one in the direct sun and one in complete shade. (Be sure they are in locations that will not be disturbed by other students. We suggest making a sign for each station that says something like: "Do Not Disturb, Science Project in Progress.") At each location, set up your experiment stations (preferably up off the ground).
 - Put a thermometer in each of the identical temperature data containers and place one at each station (one in the sun and one in the shade). (If you only have one

LEARNING OBJECTIVES

Upon completion of this lesson, students will be able to:

- discuss how sunlight affects the temperature and evaporation rate of water.
- prepare and analyze a graph depicting changes in temperature over time.
- predict how exposed surface area and exposure to sunlight might affect a given body (or container) of water.

TIME NEEDED

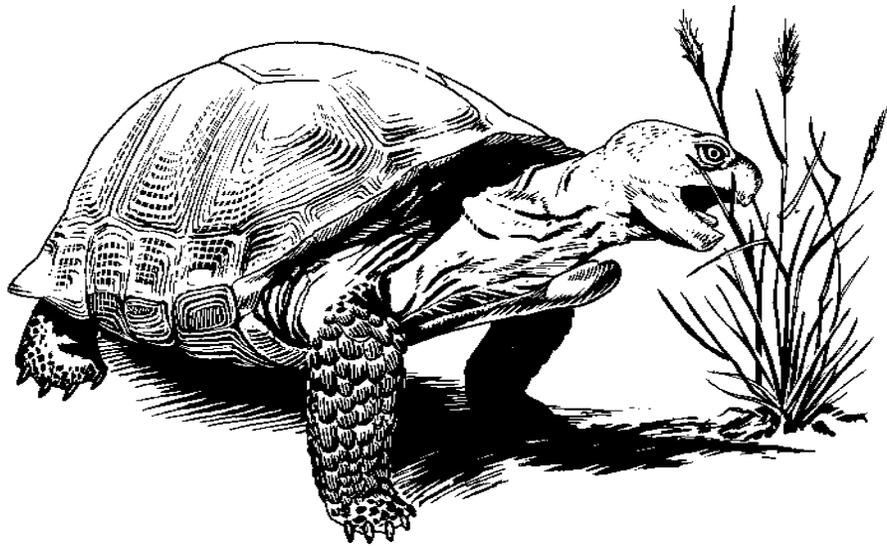
Two class periods, one to conduct the experiment (read and record data) and one to complete the lab reports. Note: Students will be occupied for only a portion of the first day when they rotate through the lab stations. You may want to consider an activity to keep the rest of the class occupied while others are reading and recording data.

MATERIALS NEEDED

- Background Information Fact Sheet: *A Review of Ecology and the Sonoran Desert Ecosystem* (from Lesson 3)
- Student Activity - Data Sheet: *Abiotic Factors in a Desert Environment*
- Student Activity - Lab Report (two pages)
- two thermometers (you can conduct the experiment with only one if necessary)
- two identical, clear glass containers
- one graduated container with an opening of not more than 2 inches in diameter (labeled SSA)
- one graduated container with an opening of at least 5 inches in diameter (labeled LSA)

CURRICULUM TIES

Arizona: 3SC-P2; 3SC-P4; 5SC-P3; 6SC-P6; 6SC-P7
O'odham: A.2.8; A.6.3



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thermometer you will have to use it for all your temperature measurements and therefore need to give it time to equilibrate for each reading.)

- Place both of the graduated containers at the station located in the sun (they could also both be placed in the shade but the sun station should give more radical results).
- Decide in advance how to obtain a full day's worth of temperature and volume data from your lab stations. You will want data collected at least once each hour throughout the day. If you teach several different periods of the same class, students from each class can collect and record data. If your class schedule is not such that different classes can contribute to the data collection, ask for student volunteers from the class in which this activity is conducted to come at specific times to collect and record the data. Write out a schedule on the chalk board listing the student's name and the time they are to come and record data. If the class in which you conduct this activity is taught in the afternoon, make the data collection assignments the day before this activity is conducted so that you start collecting data first thing in the morning and continue each hour thereafter. (We also suggest you prepare a "hall pass" in advance for the students who are assigned to come and collect the data.)
- Just before you begin the experiment for the day, fill all of your containers with water. The graduated containers should begin with 250 ml of water. You might use your graduated containers to measure equal amounts of water for the other containers.
- On the chalkboard, create two large data tables (one for time and temperature and one for time and volume) on which students may enter their data (make tables large enough to contain the entire day's data). (Refer to the data tables in the student lab report forms if necessary.)

TEACHING STRATEGY

1. **Review previous activity.** Introduce this lesson with a review of the previous activity in which students observed biotic and abiotic factors in the environment. Have students recall some of the abiotic factors they noted from that lesson. Point out that today's activity focuses specifically on abiotic factors. Ask students to consider their choices in observation sites during the previous exercise. "Did some of them prefer to sit in the shade or sun?" "Was it hot or cool enough outside to have a preference?" "Why would anyone have a preference for one or the other anyway?"
2. **Review background information.** Review the background information about abiotic factors in the desert environment. For discussion purposes, you may want to list on the board the primary abiotic factors as presented in the fact sheet. Point out that this lesson focuses on sunlight, a key abiotic factor in desert life.
3. **Create teams of four students each and hand out a data sheet to each team.** Use the student data sheet as a guide as you explain today's lab activity. Remind students that they should conduct this investigation using the scientific method, review if necessary the basics of the scientific method.

4. **Conduct the lab activity as outlined below:**

- teams should take turns visiting the experiment stations to gather and record data
- team members should work together to read and record temperature and volume measurements
- data should be recorded using correct units
- have students return to the classroom and record their team's data on the data tables on the chalkboard.
- students will copy the data table on their Lab Report form after all data has been collected (from the entire day)

5. **Hand out Lab Report forms, copy and graph data, and complete lab reports**

- once all the data is collected (from the entire day), students should copy the data table in their Lab Report. (note: there will be several data points from the different student teams for each class. Decide as a class, which data points will be used, e.g., a class average, each person uses their own, etc.--you may want to pre-select these data points and offer students a revised data table on the board)
- students should next create a line graph and plot the data points appropriately
- after graphs have been completed, have students complete the rest of their lab reports by summarizing their results and making conclusion statements
- students should answer all the discussion questions on the data sheet and lab report

6. **Wrap up using the discussion questions as a guide.** The discussion should focus on the influence of sunlight and temperature in a desert environment. It is also important to note that sunlight and temperature not only affect other abiotic factors such as water, they also affect the living things in the environment.

EXTENSIONS

Weather station. Set up a weather station at your school. Typical data collected at weather stations include rainfall, temperature, windspeed, and cloud cover. You might ask your local news station for assistance.

ABIOTIC FACTORS IN A DESERT ENVIRONMENT

Team Member Names _____ Class _____

Directions: With your team, go to each of the lab stations and read and record the temperature and volume of water in the different containers. Do not forget to record the time of day! Enter your data in the appropriate space on your data sheet below. For Part 1, you will be looking at the effect of the sun versus shade on water temperature. For Part 2, you will be looking at the effect of the size of exposed surface area (container opening) on evaporation of water. When the entire day's data is collected, complete the data tables on your lab reports. Answer the discussion questions below.

Part 1. - Temperature Effects

Effect of the sun versus shade on water temperature.

Time of Day _____

Water Temperature in Shade _____

Water Temperature in Sun _____

Part 2. - Volume Effects

Effect of size of exposed surface area (container opening) on evaporation.

Time of Day _____

Water Volume in Small Surface Area (SSA) Container _____

Water Volume in Large Surface Area (LSA) Container _____

Discussion Questions (Answer these questions as a team, choose one person to record your answers.)

1. How do you think the sun affects water temperature?
2. What effect do you think that exposed surface area has on water evaporation?
3. Why is evaporation an important consideration in a desert environment?
4. From what kinds of surfaces does water usually evaporate?
5. The average potential evaporation rate in the Sonoran Desert ranges from about 93 inches per year in Nogales to 120 inches per year near Yuma. Suppose you were a hydrologic engineer hired to design a huge reservoir to store water in your area. What would be some of the considerations for your design? Describe how you would design this water reservoir in the desert. Use the back of this paper.

Name _____

Class _____

Title: _____

Directions: Title this lab report. Make your prediction about the outcome of this experiment. Complete the table using all the day's data. Graph your results on the back of this paper or on a separate sheet of graph paper. Analyze and write your results. Make your conclusion about the experiment -- did your prediction prove correct based on the observed data? Why or why not?

Prediction: _____

Data Table:

Time	Water Temperature in Shade	Water Temperature in Sun

Results: _____

Conclusion: _____

Name _____

Class _____

Title: _____

Directions: Title this lab report. Make your prediction about the outcome of this experiment. Complete the table using all the day's data. Graph your results. Analyze and write your results. Make your conclusion about the experiment, Did your prediction prove correct based on the observed data? Why or why not?

Prediction: _____

Data Table:

Time	Water Volume of SSA Container	Water Volume of LSA Container

Results: _____

Conclusion: _____

BIOTIC FACTORS OF THE SONORAN DESERT

SOME COMMON PLANTS AND ANIMALS SHARING OUR DESERT HOME

LESSON OVERVIEW

This lesson offers a variety of options for studying the life histories of some common plants and animals of the Sonoran Desert. The class is provided with a set of illustrated "cards" describing the life histories of selected plants and animals of the region. Depending on the needs of the class, you may select from a "smorgasbord" of activity ideas utilizing the cards in classroom instruction. The purpose of this lesson is to give you and your students the opportunity to learn more about our plant and animal neighbors of the desert. It is also a chance for you to tailor provided resource materials to the needs of your class.

TEACHER PREPARATION

✓ We have provided a listing of activity ideas under "Teaching Strategy." Review these ideas and select an appropriate lesson (or lessons) for your needs. You may also design your own activity using the provided Life History Cards. Note: because we are only able to provide each classroom with one set of the Life History Cards, you may want to make copies of the Teachers' Master Set of Life History Cards. These additional copies could be available for students to read and study (which is necessary for some of the suggested activities).

TEACHING STRATEGY

Plant and Animal Experts. Assign each student or pair of students a specific plant or animal card. Have students become the "expert" on their assigned organisms. Give them time to study their cards and if possible, conduct additional research on their organism. Have each student make a presentation to the rest of the class about their organism. The presentations could be visual (students make informative posters), or oral (students give a talk about their organism), or a combination of both.

Interacting Plants and Animals. Have students work in teams with each team responsible for a grouping of Life History cards. (The groupings may be random or pre-planned.) Each team should carefully review their collection of Life History Cards and consider how the specific organisms interact with each other. Student teams should prepare some type of presentation to convey their information to the rest of the class. Ideas for presentations include: murals depicting the plants and animals interacting in some way in a desert setting; short plays or skits conveying the roles of the organisms in the desert environment; "game shows" with plants and animals being the "players"; panel presentations with plants and animals being the panelists; or newscasts with plants and animals being interviewed, etc. Students may also come up with their own ideas for presentations.

Card Games. Have teams of students play card games using the Life History Cards. They might play a game of "Concentration" or "Old Maid" in which "two of a kind" could be two species of mammals, or cactus, or birds, etc. Allow students to invent their own card games with the Life History Cards.

LEARNING OBJECTIVES

Upon completion of this lesson, students will be able to:

- name (in Spanish, English, and Tohono O'odham) at least 3 plants and 3 animals residing in the Sonoran Desert.
- give the scientific names of at least 3 plants and 3 animals of the Sonoran Desert.
- describe the life histories (habitat, range, behavior, and interactions) of at least 3 plants and 3 animals residing in the Sonoran Desert.
- describe at least 3 human interactions (uses, etc.) with specific plants and animals of the region.

TIME NEEDED

Class time for this activity will vary with the chosen activity but may range from one to several class periods.

MATERIALS NEEDED

- *Sonoran Desert Plant and Animal Life History Cards*

CURRICULUM TIES

Arizona: 4SC-P1
O'odham: A.4.3; A.6.3; B.7.2



Bingo. Have students play Life History "Bingo". Students could make up their own bingo cards by organizing the names of 9 or 16 plants or animals on a square grid. The bingo "announcer" would read the life history information of the organism (as opposed to just reading the name) and students mark off their squares accordingly. Winners must review their winning organisms aloud to ensure they have marked the correct organisms. Note: students would have to have some time to study the cards in advance of playing the game so they had some familiarity with the organisms.

Aspects of Life History. Have student teams focus on certain aspects of the Life History Cards, such as "Human Uses" "Behavior", or "Range." Students could then write reports on a group of organisms which have specific similarities under those headings. Ideas include medicinal plants and animals; Endemics - organisms which occur only in the Sonoran Desert; nocturnal life in the desert; predators in the desert; harvesting the desert; etc.

Flash Cards - Who Am I? Student work in small teams to study then quiz each other on a small collection of Life History Cards. After each team feels comfortable with their collection of cards, the teams switch cards and repeat the process until all teams have studied all cards. The class could then play a game in which the teacher (or a student) secretly selects a card and reads an aspect of the life history information aloud to the class. Students work in their teams to guess the plant or animal. The team with the most correct answers, wins.

What's in a Name? Students could study the cards as suggested for the "Flash Cards - Who Am I?" activity listed above. However, for this exercise, students could focus specifically on the English, O'odham, Spanish, and scientific names of the organisms. The group quiz game could involve the teacher reading the name in a language other than the classroom dominant language or give the scientific name. In that case students should give the name of the organism in their primary language. The teacher could also give the common name and ask students how to say it scientifically or in another language.

EXTENSIONS

Nature Walk. Take a nature walk around the school grounds and see how many of the plants and animals from the Life History Cards the students can find. As they locate a plant or animal, discuss its life history.

Create Life History Cards. Have students create new life history cards about plants and animals not included in the provided collection.

STUDENT EVALUATION

Name _____

Class _____

Matching - Write the letter of the correct term for each definition listed below:

- | | |
|--|-----------------------------|
| 1. ____ the study of the interrelationships between living things and their environment | a. abiotic factors |
| 2. ____ the area in which we ourselves live, taking into consideration our climate, topography, and biological communities | b. species |
| 3. ____ organisms of the same species living in a specific area | c. diversity |
| 4. ____ where an organism lives and obtains its food, water, and shelter | d. Sonoran Desert Ecoregion |
| 5. ____ the non-living parts of the ecosystem | e. population |
| 6. ____ a group of closely related organisms which can breed to produce offspring | f. ecoregion |
| 7. ____ all the living and non-living things in a given area, and their interactions | g. biotic factors |
| 8. ____ a measure of the variety of different living things on Earth | h. ecology |
| 9. ____ the living things in an ecosystem | i. habitat |
| 10. ____ a large expanse of land and/or water delineated by similar climate, topography, and biological communities | j. ecosystem |

Questions - Write the correct answers in the space provided:

- List three abiotic factors which affect your life everyday:

11. _____ 12. _____ 13. _____

- List two biotic factors which you might detect if you stepped outside your classroom:

14. _____ 15. _____

- Name three nations in this region participating in the Juntos program:

16. _____ 17. _____ 18. _____

• Name two rivers that occur within our Sonoran Desert Ecoregion:

19. _____ 20. _____

• Name one natural, protected area in the region:

21. _____

• List two plants native to the region:

22. _____ 23. _____

• List two animals native to the region:

24. _____ 25. _____

Map - *In the space below draw a map which included the following features:*

- | | | |
|-------------------------------|---------------------------|----------------------------------|
| 26. The Mexico - U.S. border | 31. Nogales, Arizona | 36. The Gulf of California |
| 27. Southern Arizona | 32. Sells | 37. Nogales, Sonora |
| 28. Yuma | 33. Northern Sonora | 38. Sonoyta |
| 29. The Tohono O'odham Nation | 34. San Luis Rio Colorado | 39. Upper Gulf Biosphere Reserve |
| 30. The Colorado River | 35. Ajo | 40. North Arrow |

Extra Credit: - *On your map, locate and label the following natural areas:*

- Baboquivari Mountains Pinacate Biosphere Reserve Cabeza Prieta National Wildlife Refuge

